

Habitat selection

Choose a species-specific “optimal” habitat to increase the reproductive success

What is migration ?

A form of dispersal, movement away from and subsequent return to the same location on an annual basis.

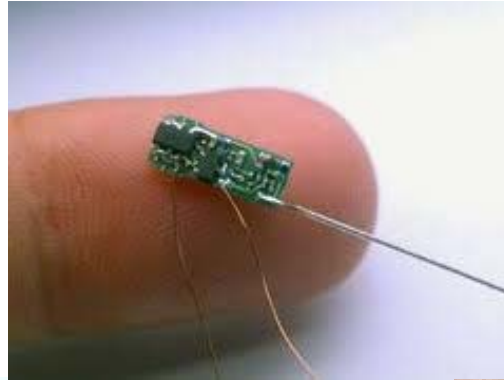
Tools to trace migratory routes

1. banding; tagging
2. radio-transmitter
3. satellite radio-telemetry
4. stable isotope

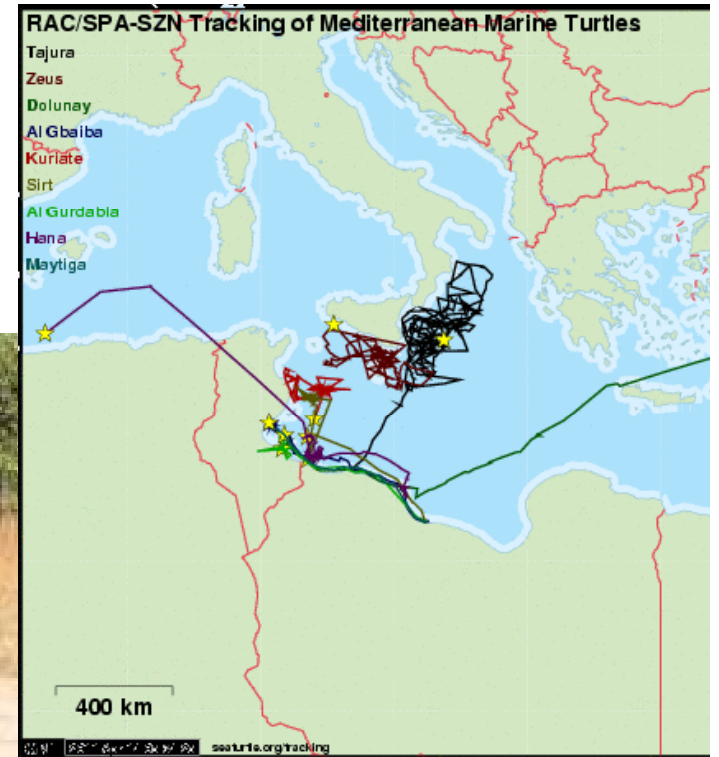
Banding



Radio-telemetry



Satellite telemetry

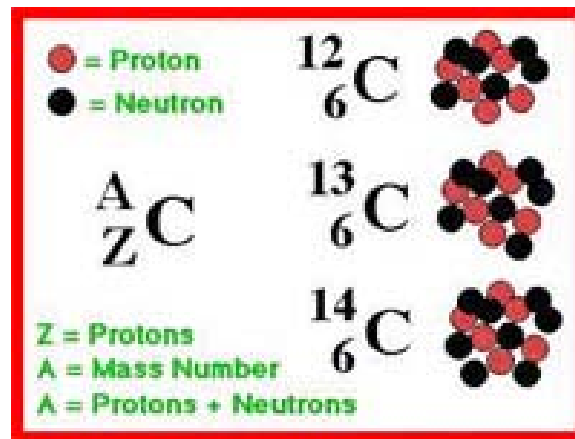
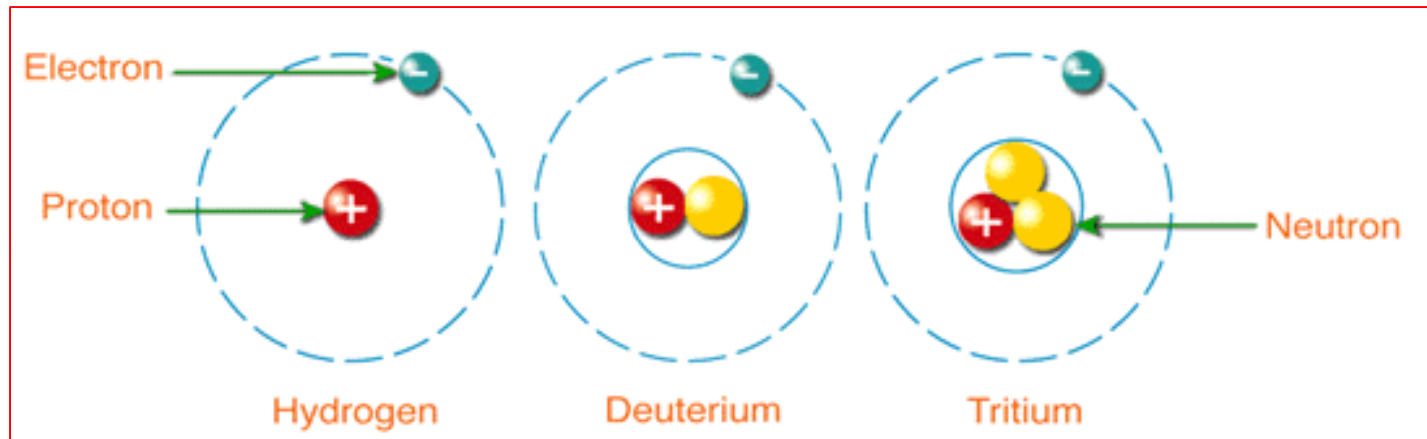


Stable isotope

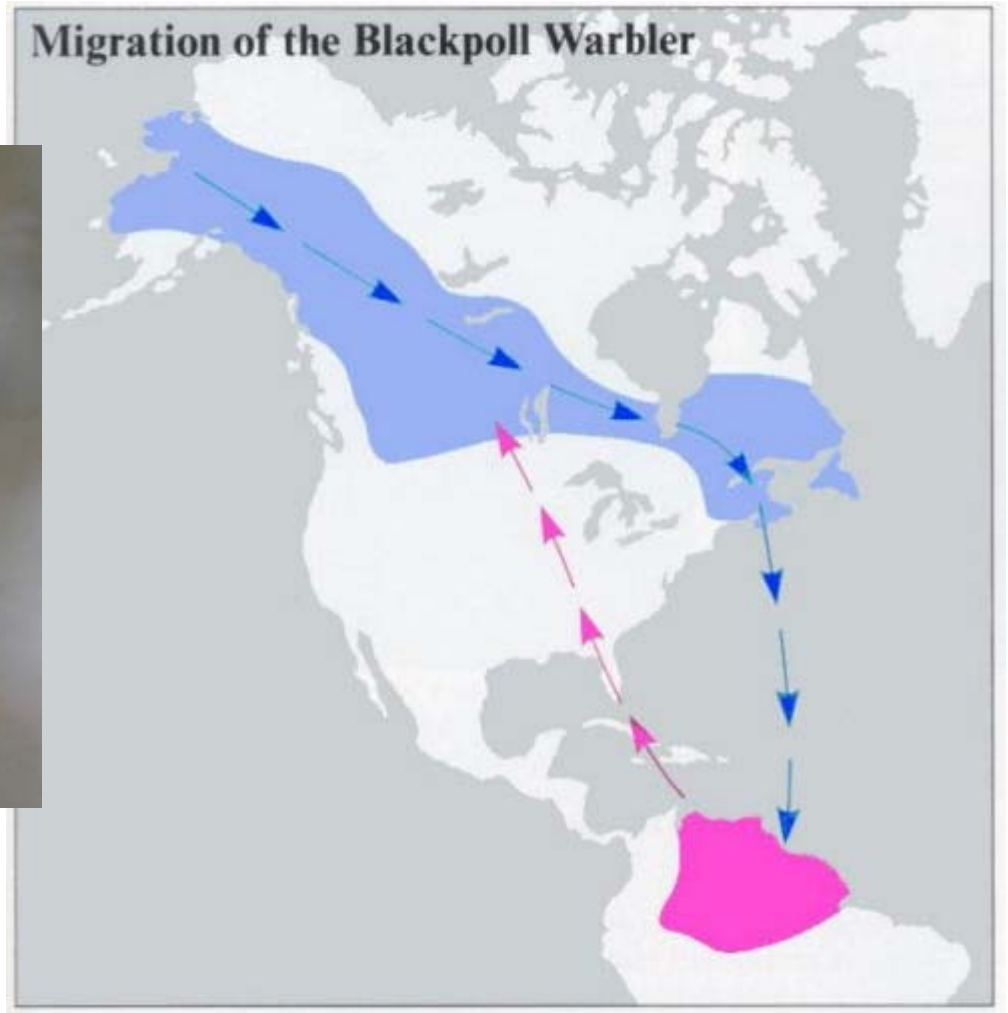
^1H

^2H

^3H (heavier hydrogen)



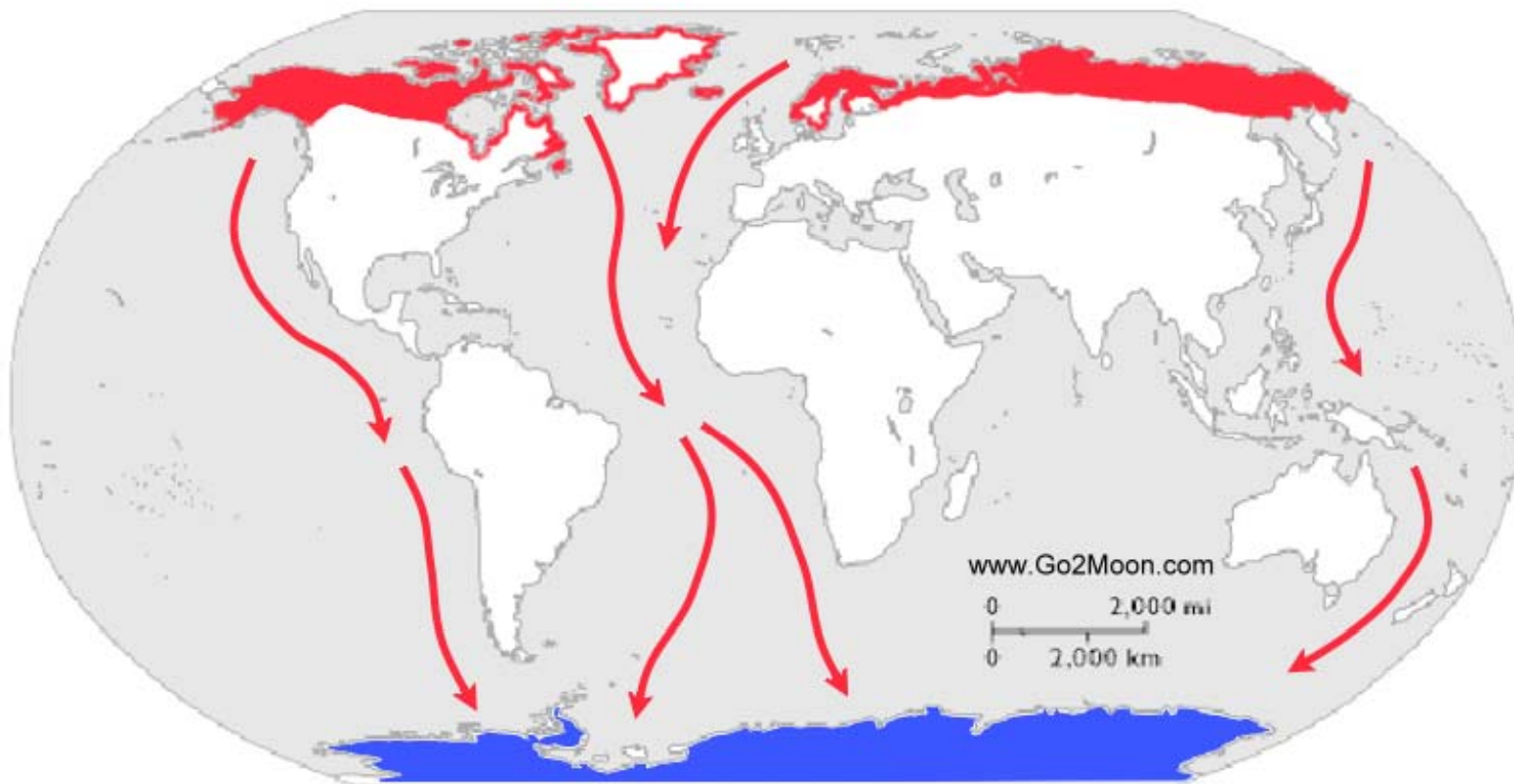
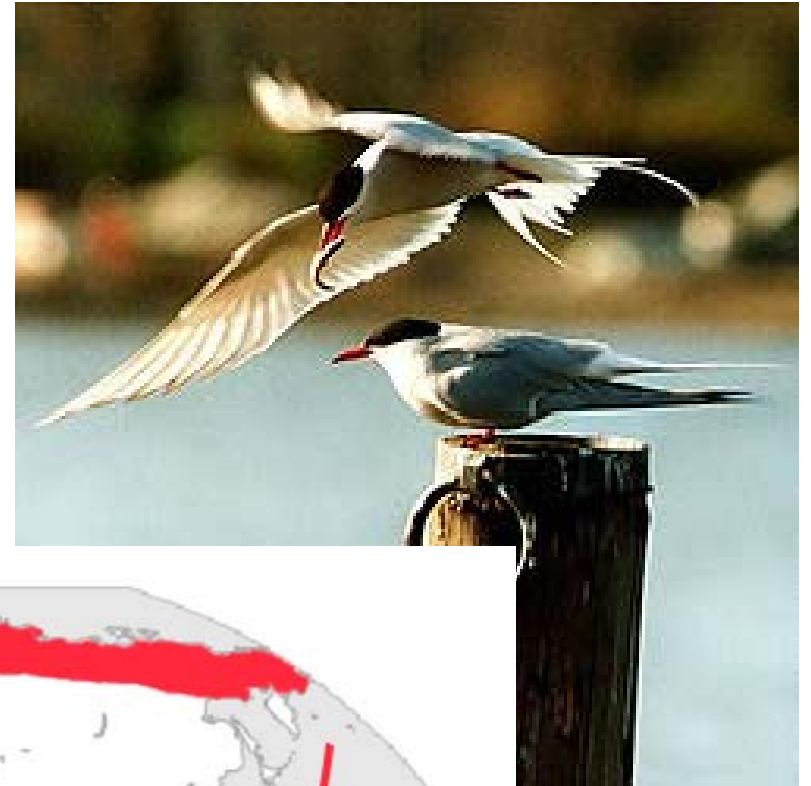
Blackpoll Warbler



Nearly half of all the breeding birds in NA are migrants

Arctic tern

12,000 miles each way

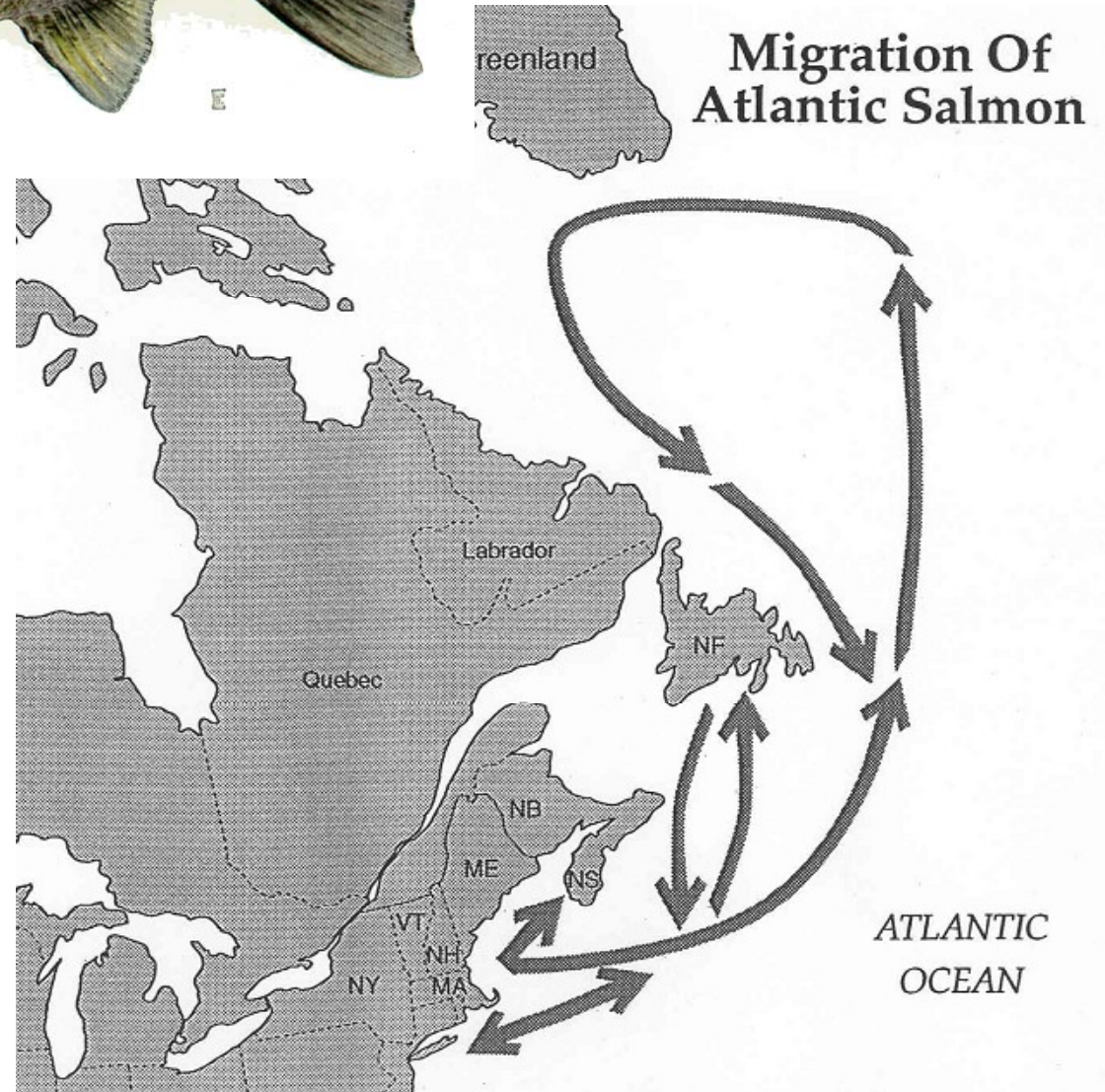


The animals kingdom's longest migration award goes to the Sooty shearwater-----39,000 miles

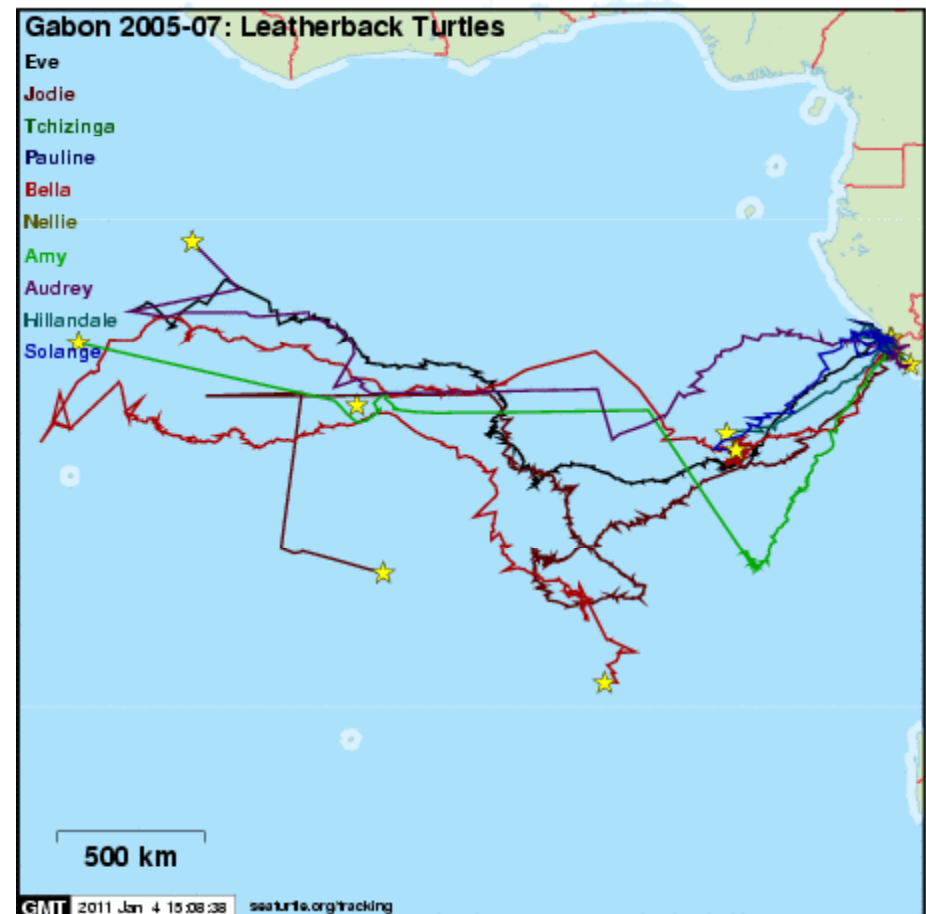
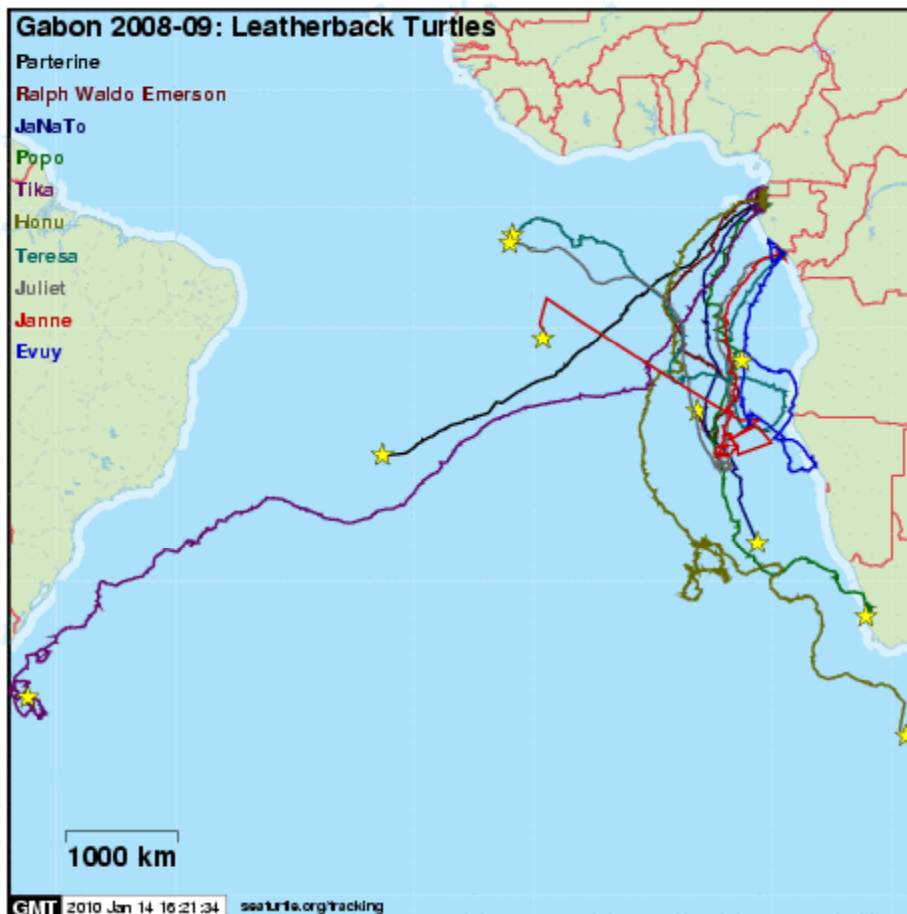




Atlantic Salmon



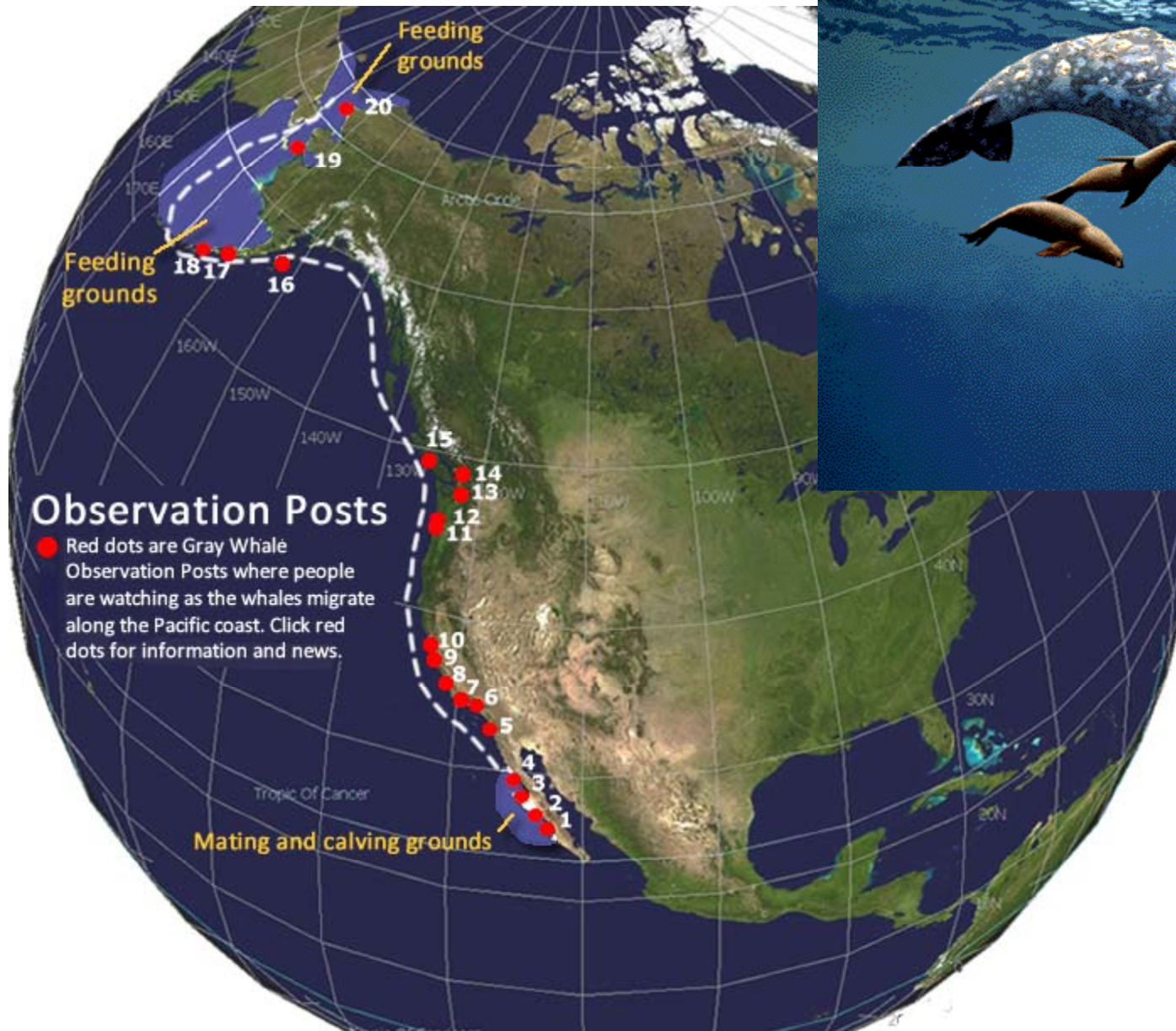
Loggerhead sea turtle



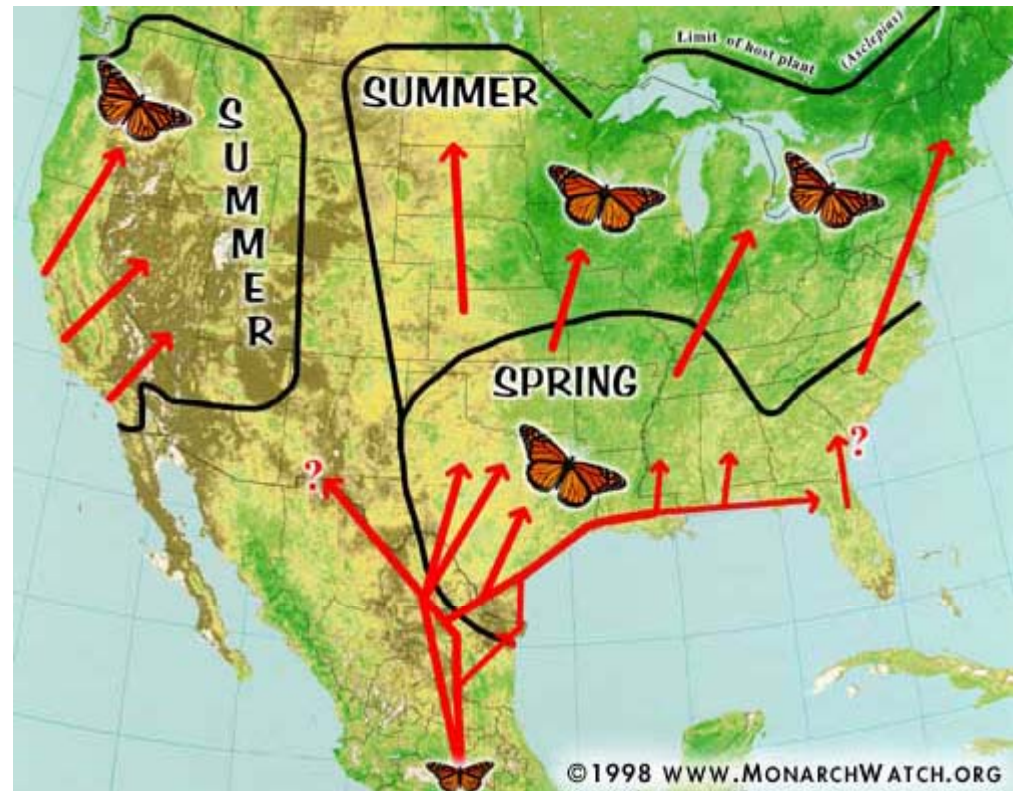
Wildebeest



Gray whale



Monarch butterfly: 3000 miles, multi-generation migration



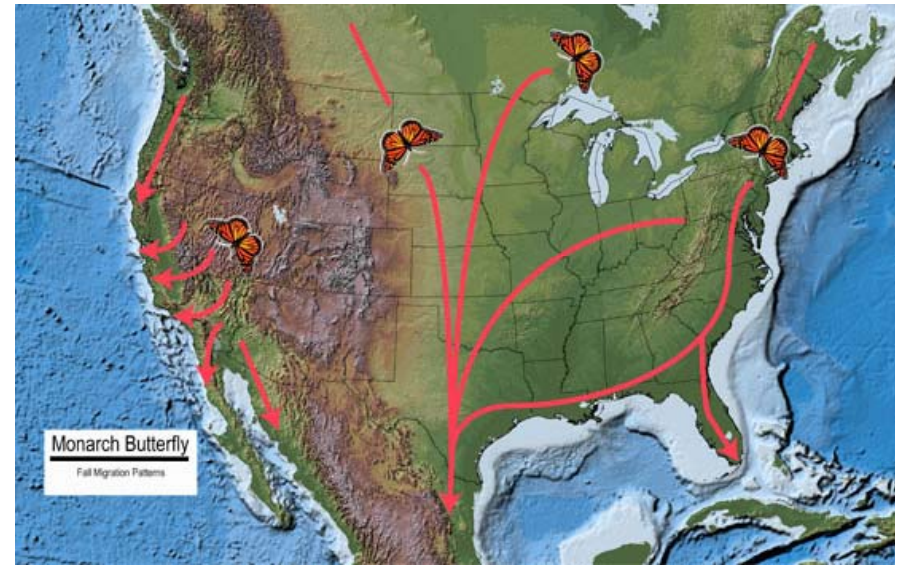
Monarch butterfly migration



Travel South (fall):

Eastern North American monarchs fly south using several flyways then merge into a single flyway in Central Texas.

3600km in 75 days: 50km per days



Wintering

Overwintering Monarchs clustering on Oyamel trees (2500-3500 m height) in Angangueo, Michoacan, Mexico.

Monarch butterfly: overwinter sites



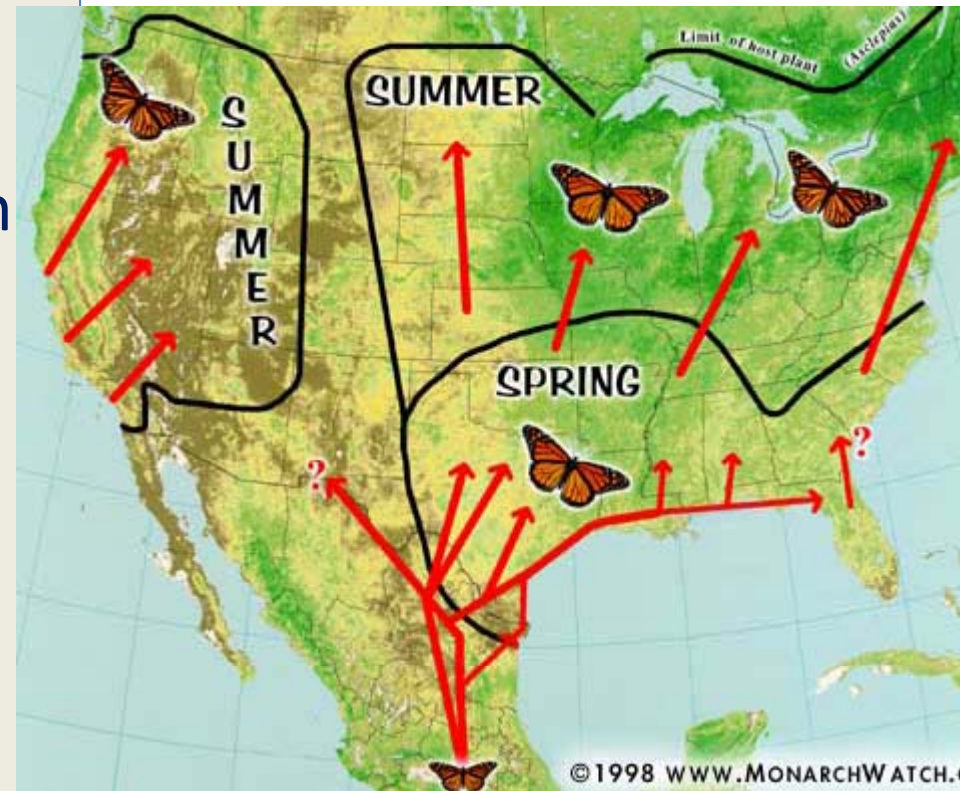
Travel North (spring): several generations

Early spring, to gulf coast, lay eggs.

Offspring of the first generation
→ Great lake and southern
Canada; lay eggs

Offspring of the second
generation → to east; lay eggs

Offspring of the third generation
→ fall migration



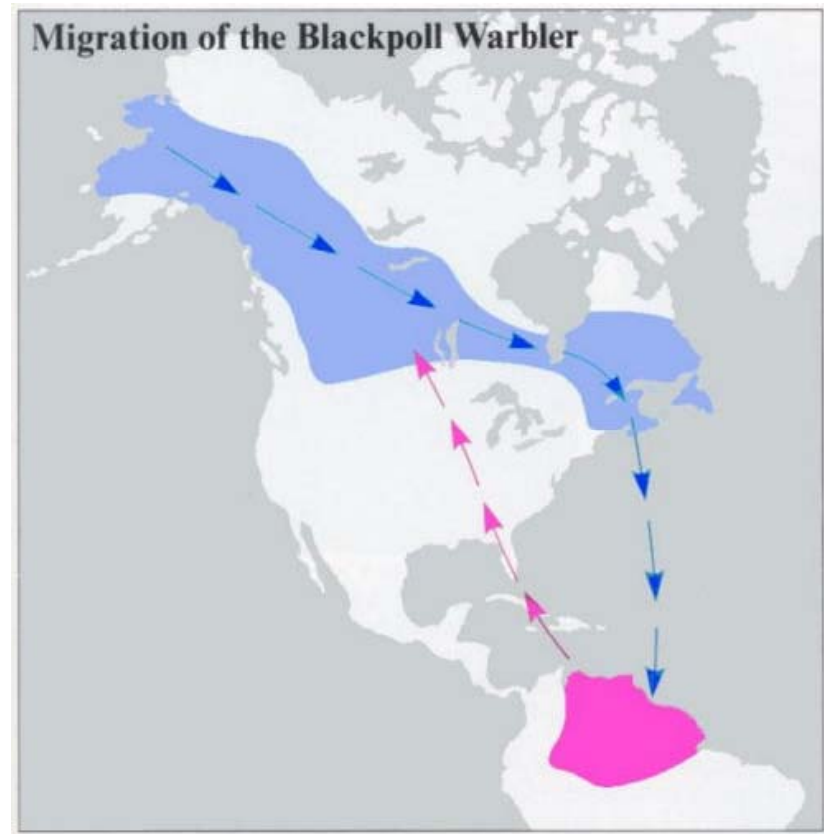
Why do animals migrate?

Ultimate causes?

Why do animals migrate?

The costs of migration

1. Energy: large fat reserve
2. Predator



Why do animals migrate?

The costs of migration

1. Energy: large fat reserve
2. **Predator**

Many predators wait at migratory stopover sites to capture exhausted migrants



Why do animals migrate?

The **benefits** of migration

1. Abundant food in the north (temperate zone) during summer (insects...).
2. Less predators in the north during summer.
3. Longer hours of summer daylight in the north than staying in tropics.
4. Weather: Warmer temperature for wintering in tropics

How do animals migrate?

Proximate causes

Migratory behavior:

learned or innate?

Blackcaps: an European warbler

Population #1: fully migratory (central Europe)

Population #2: non-migratory;
resident all year long (an island close to Africa)



How do you design an experiment to determine if the migratory behavior is under genetic control?

Blackcaps: an European warbler

Population #1: fully migratory (central Europe)

Population #2: non-migratory;
resident all year long (an island close to Africa)



Cross-breed between fully migratory and non-migratory ones

And your predictions??

Blackcaps: an European warbler

Population #1: fully migratory (central Europe)

Population #2: non-migratory;
resident all year long (an island close to Africa)



F1 hybrids (fully migratory x resident) = 40% are migratory

Demonstrate that genetic control of the migratory behavior

Not all of F1 become migratory: not a single genetic locus determines this behavioral trait.

Blackcaps: Experiment 2

Two populations; both are migratory,
both are from central Europe.

But have different migratory routes:

Population 1: southwest route

Population 2: southeastern route

How do you design an experiment to determine
if the migratory behavior is under genetic control?

Blackcaps: Experiment 2

Two populations; both are migratory,
both are from central Europe.

But have different migratory routes:

Population 1: southwest route

Population 2: southeastern route

Cross-breed between southwesterns and southeasterns

And your predictions??

Blackcaps: Experiment 2

Two populations; both are migratory,
both are from central Europe.

But have different migratory routes:

Population 1: southwest route

Population 2: southeastern route

F1 hybrids (eastern x western migrants) = intermediate direction

Demonstrate that genetic control of the migratory behavior

Blackcaps

Cross-breeding between
different populations of the same
species

Not only the direction, but also
distance are under genetic
control

Migratory **distance** is under
genetic control

Flight restlessness occurs at the
time when birds migrate, the longer
the migration route is, the longer the
flight restlessness lasts when the
bird is kept in the cage

Proximate causes of migration in birds

1. Sun compass: birds can use the position of the sun for orientation

Design an experiment to determine how sun compass guide bird migration?

1. Sun compass

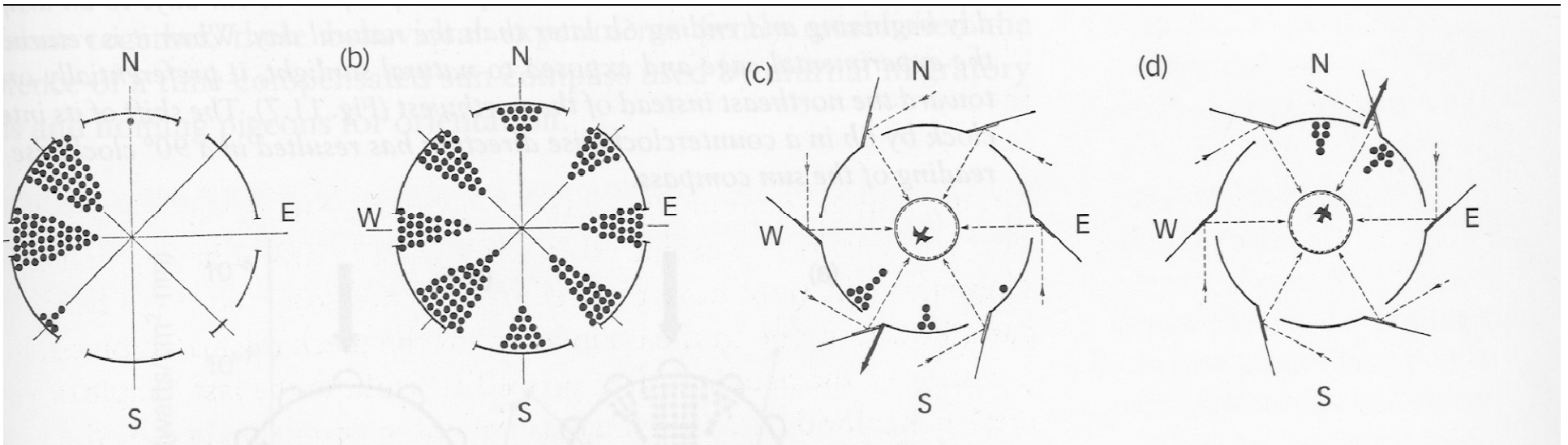
Keep migratory birds in cages, where they can see the sun, measure their flightless restlessness at the time when they usually migrate.



European starling

Sun compass

Results:



Sun

Overcast

Mirror-deflected
90 degree

Mirror deflected
90 degree

Many diurnal birds migrate at night

William Cochran (1967) captured a migrating Gray-cheeked thrush in Illinois and attached a tiny radio transmitter to it. At dusk, the thrush took off, followed by the ornithologist in a small plane. A severe thunderstorm and shortage of fuel forced their plane down that night, but the thrush flew on. After refueling, they relocated the bird in the vast night sky. The thrush landed at dawn in Wisconsin after flying 650 km on a firm compass bearing all night.

How do nocturnal migrants migrate at night?

Keep the migrants in cages:

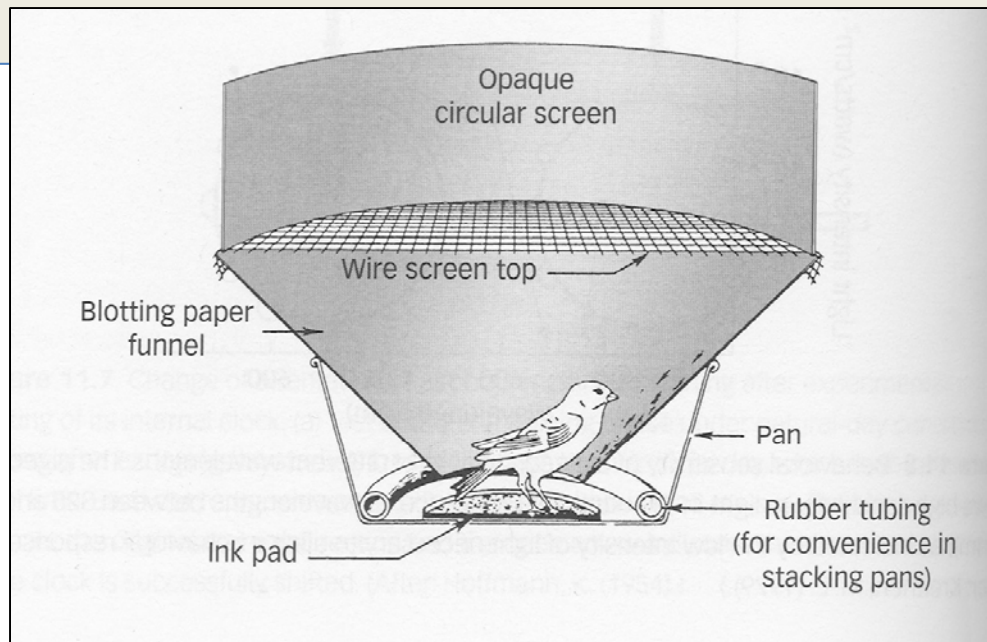
1. When kept indoors, they seem disoriented.
2. When kept in the same cage outdoors, they could see the sky. They are oriented!

Star compass

Design an experiment to test birds can use “star compass”.

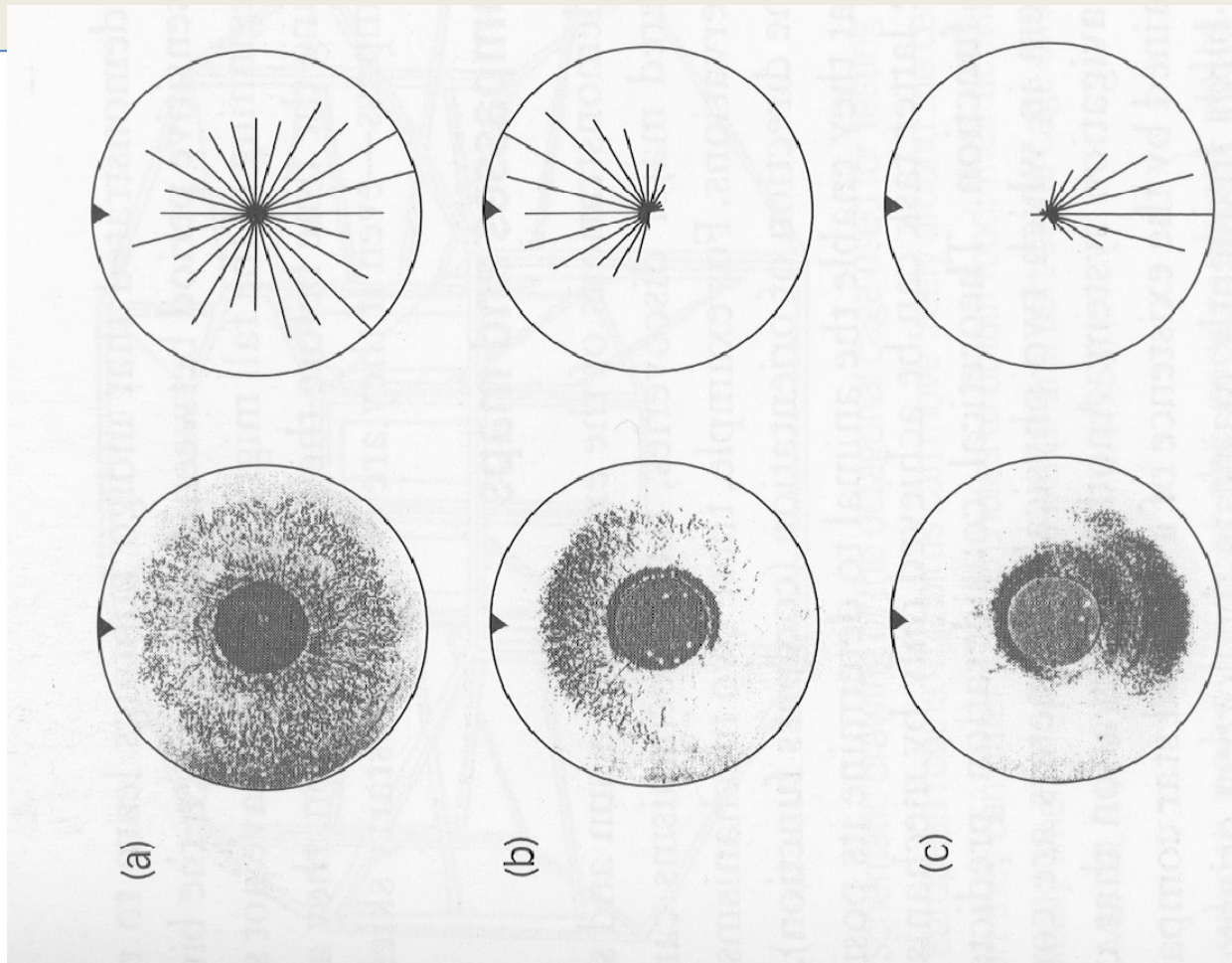
Keep the migrants in a cage (ink pad on the bottom):

1. Birds oriented under natural night sky.



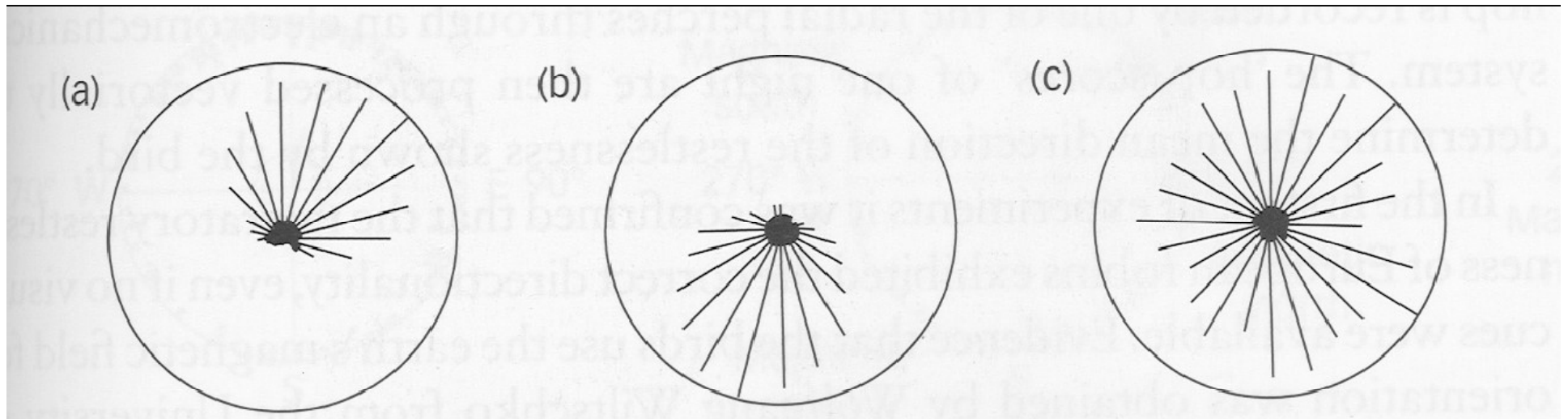
Keep the migrants in a cage (ink pad on the bottom):

1. Birds oriented under natural night sky.



Keep the migrants in a cage:

1. Birds oriented under natural night sky
2. Birds oriented the same direction under the stationary sky of a planetarium.



Spring planetarium
sky

Spring planetarium
sky, rotate 180 degree

Control group,
No star.

Star compass requires learning

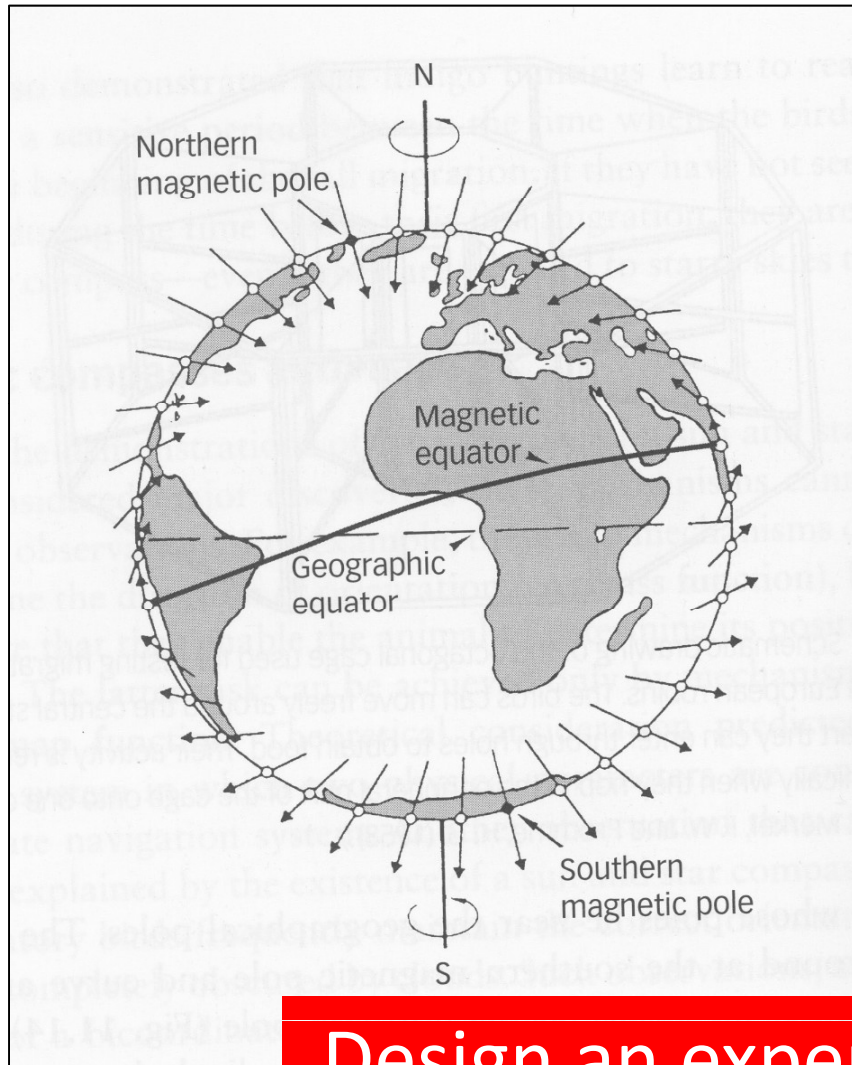
Juveniles learn to read the star compass in a “sensitive period” before migration

Sun and star compass used to determine the direction of orientation.

Many migratory birds maintain the correct orientation, even if the sky is obscured by clouds (can't read sun or stars)

Magnet compass

Magnet compass

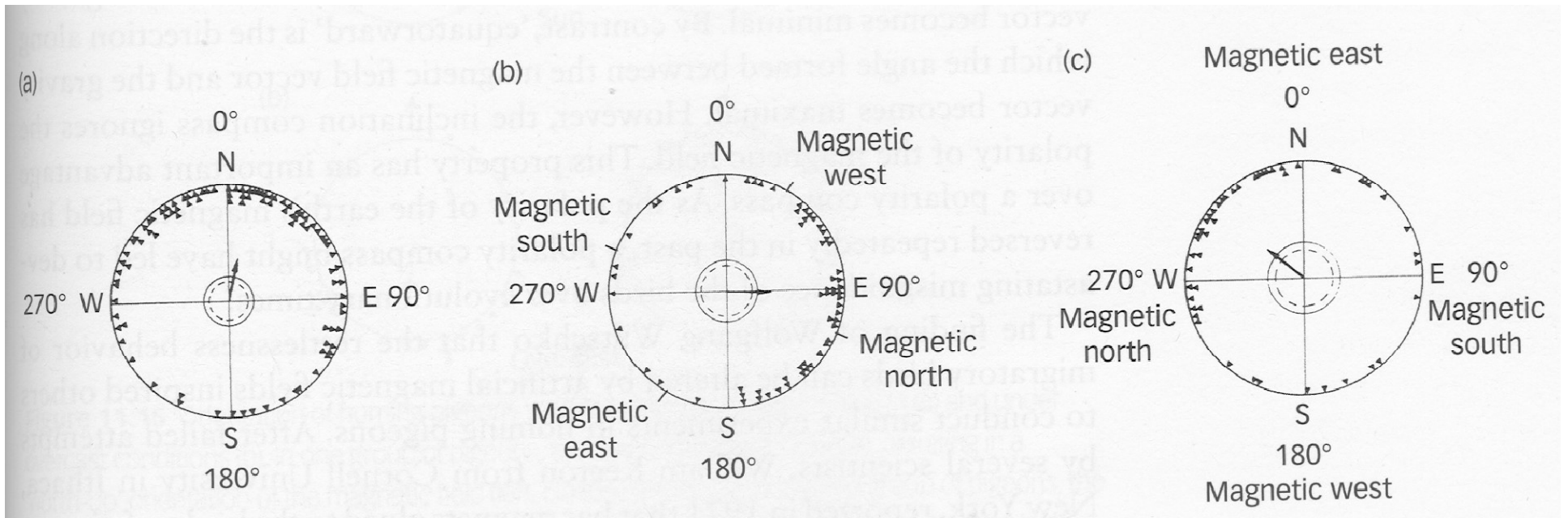
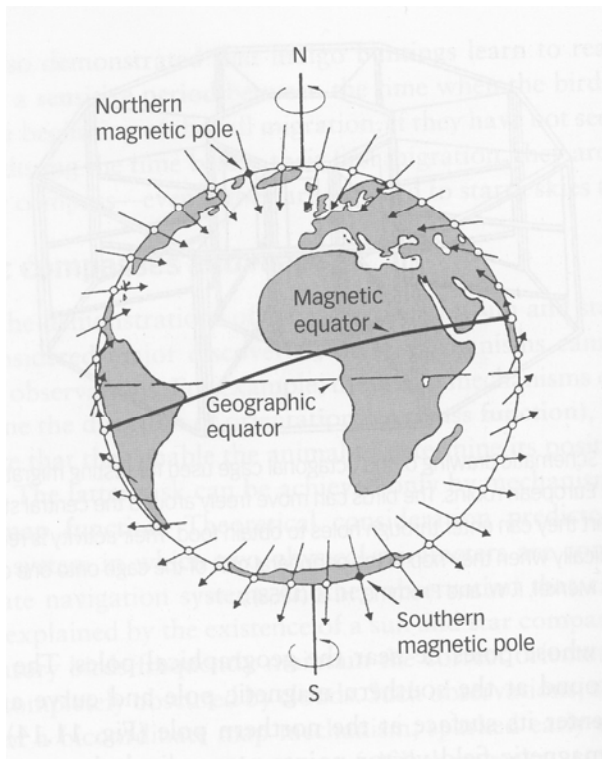


Geographic north/south
is different from
Magnetic north/south

Design an experiment to determine
if olfactory map guides orientation?

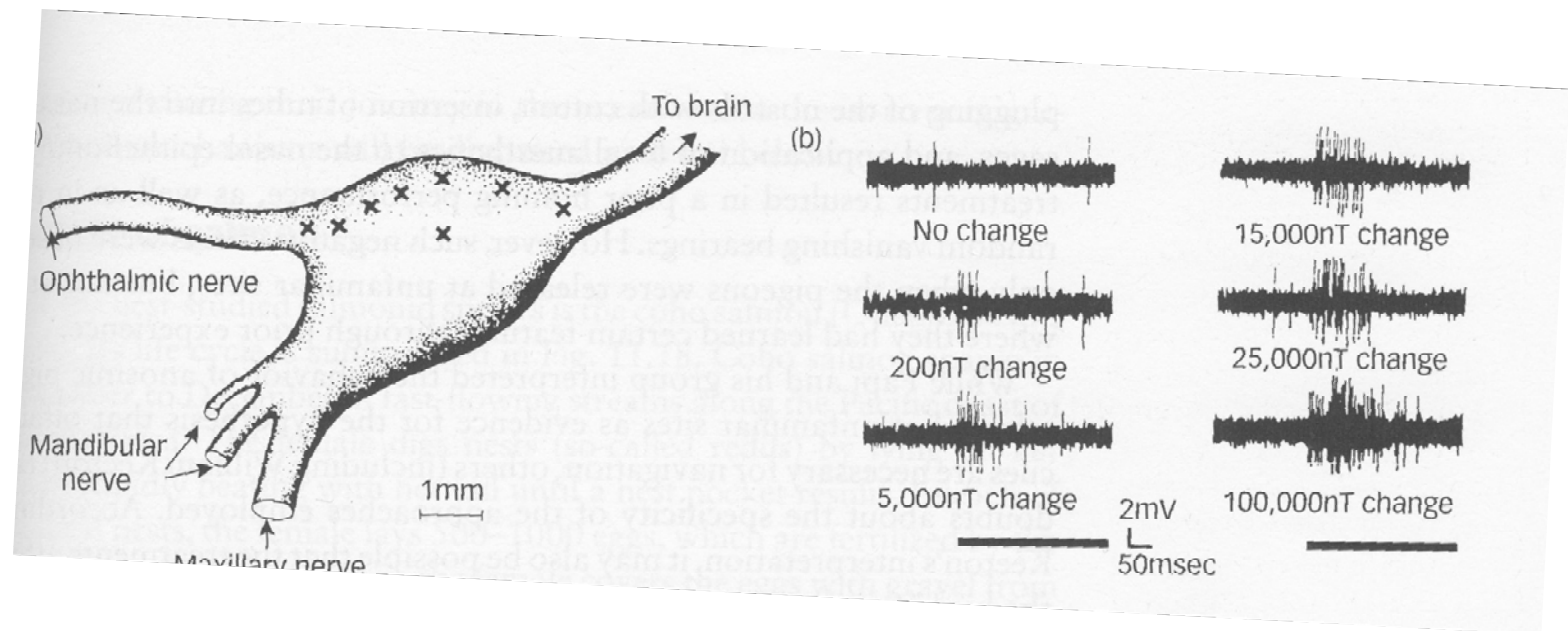
Magnet compass

Change the magnetic field,
birds change their orientation



However,

Many animals have magnet-receptor to detect the magnetic field



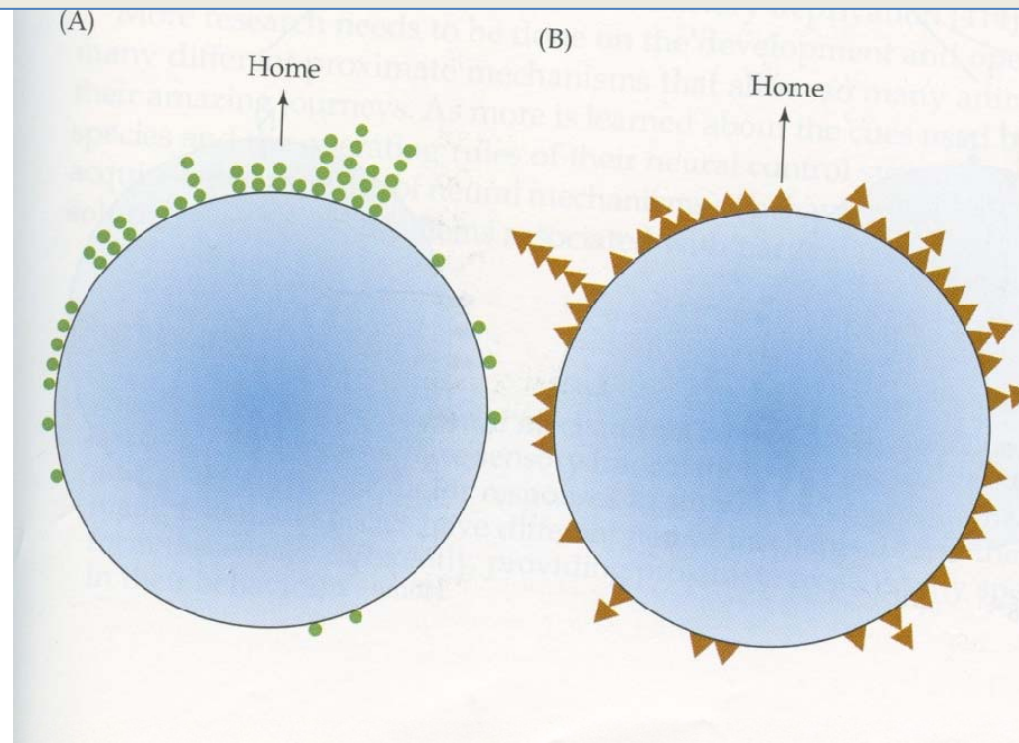
Olfactory map: smell their way home

Different locations have different odors;
A north wind and a west wind would
each have a distinctive odor

Design an experiment to determine
if olfactory map guides orientation?

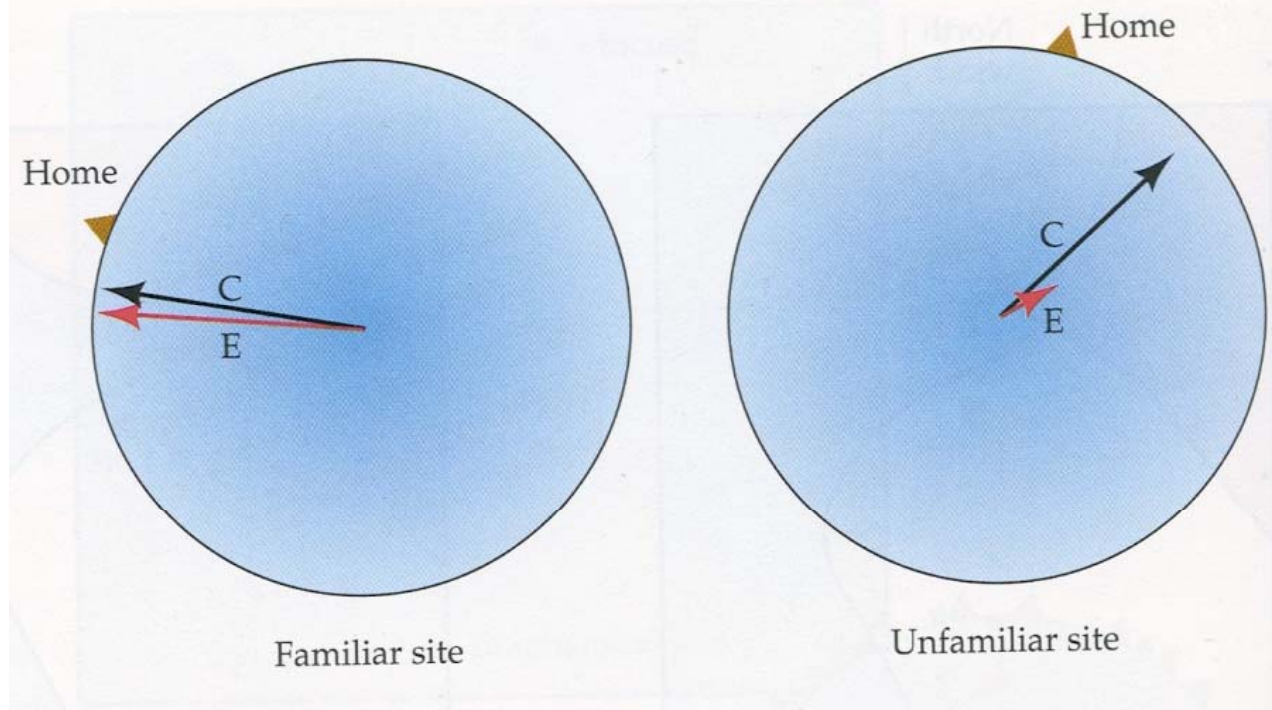
Olfactory map:

Pigeons with blocked olfaction were much less likely to orient accurately toward the home loft on release



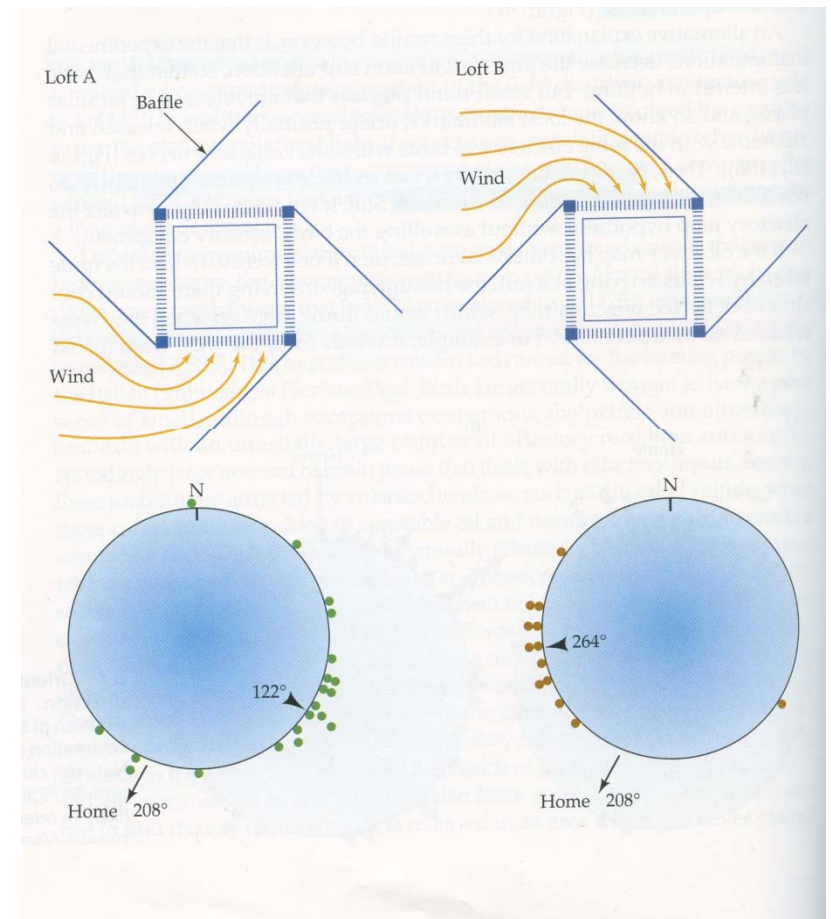
However,

The effect of blocking olfaction on orientation occurs only if pigeons were released at an **unfamiliar** site.



Further test of olfactory hypothesis

Baffles deflect the wind 90 degree,
alter pigeon's perceptions
of the direction of odors



Conclusion:

Many animals can use a combination of compass for orientation or migration.

Sun compass

Star compass

Polarized light

Magnet compass

Olfactory map

Landmark